

A warming tropical central Pacific dries the lower stratosphere

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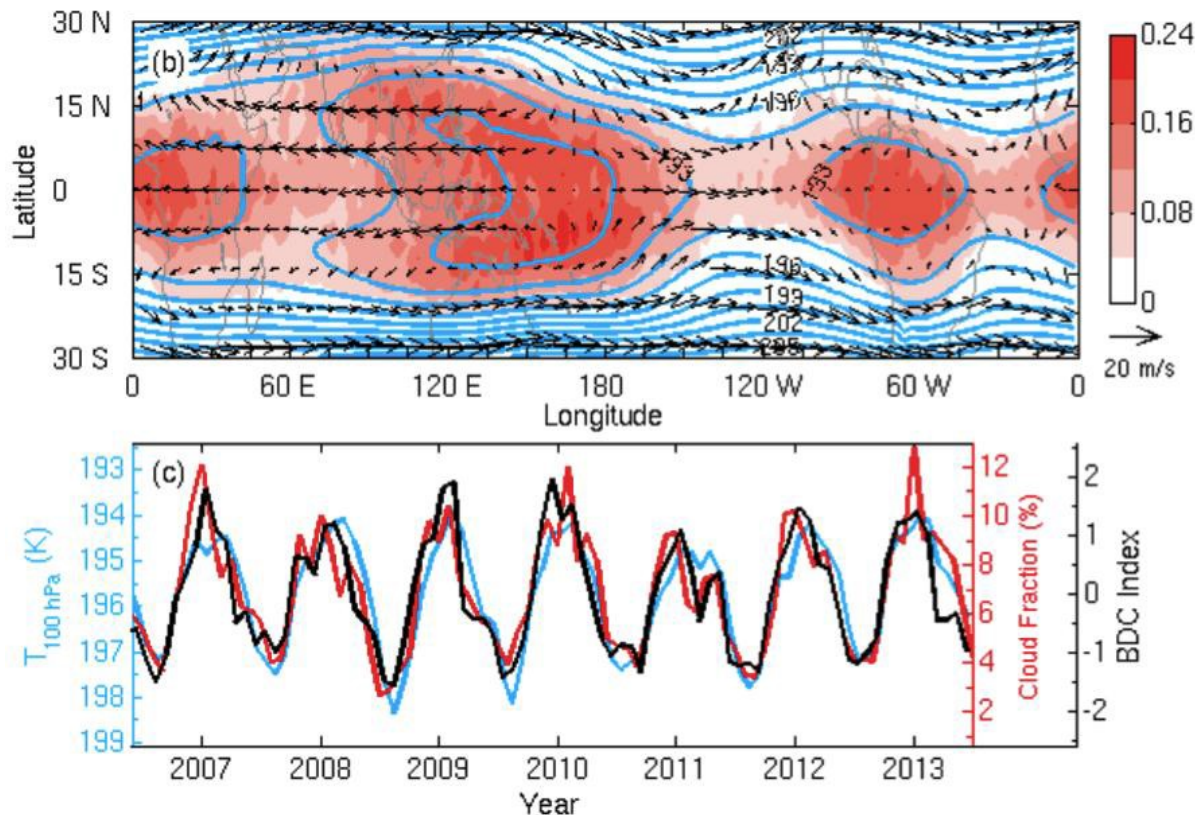
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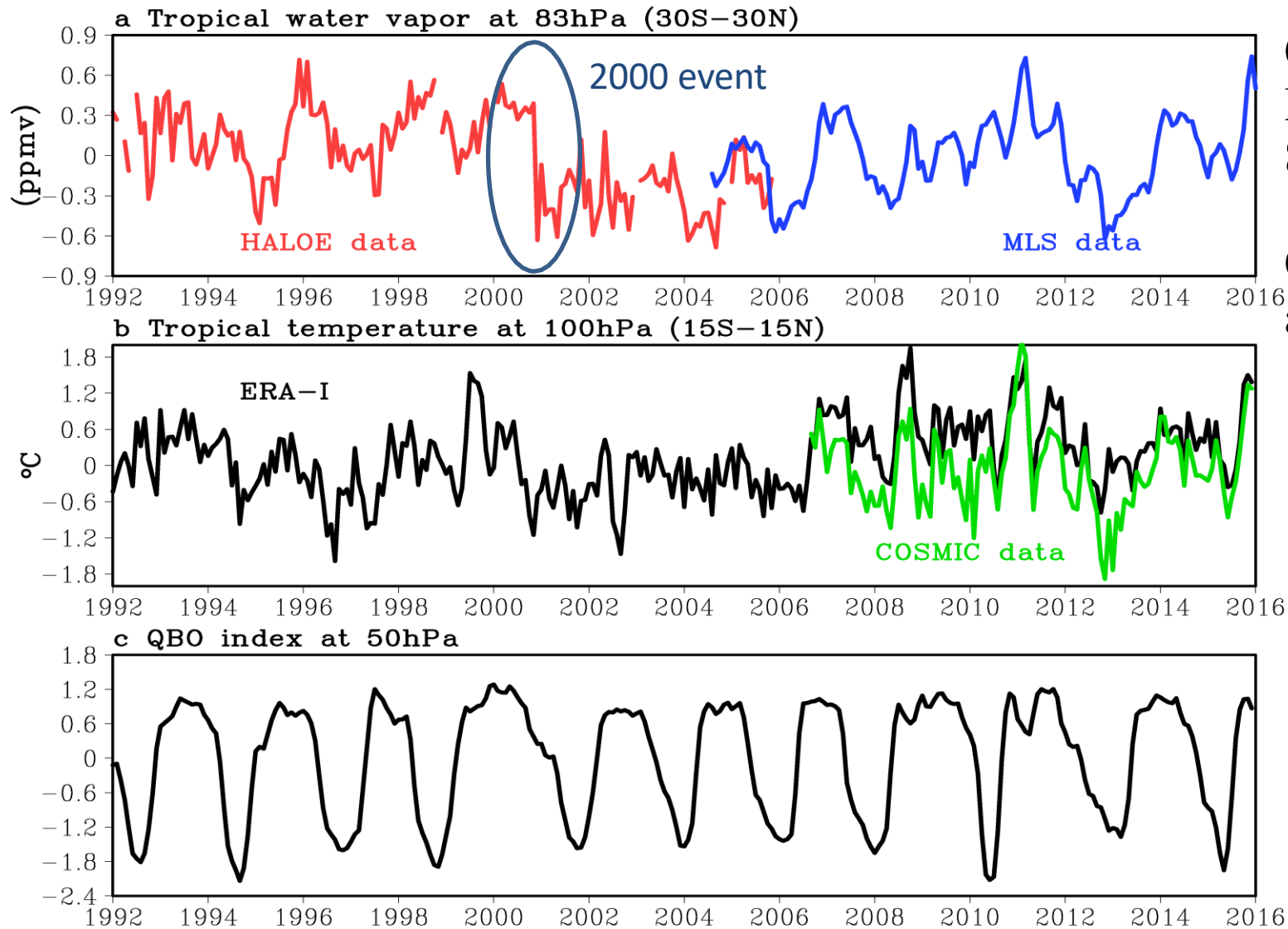
Introduction

- The amount of water vapor in the tropical lower stratosphere (TLS), which has important influence on radiative energy budget, is modulated by temperature variability in the tropical tropopause layer (TTL)
- TTL temperature variability is caused by a complex combination of tropical tropospheric processes associated with convection and stratospheric processes including the Brewer-Dobson circulation and quasi-biennial oscillation (QBO)



Fu (2013, Nature Climate Change)

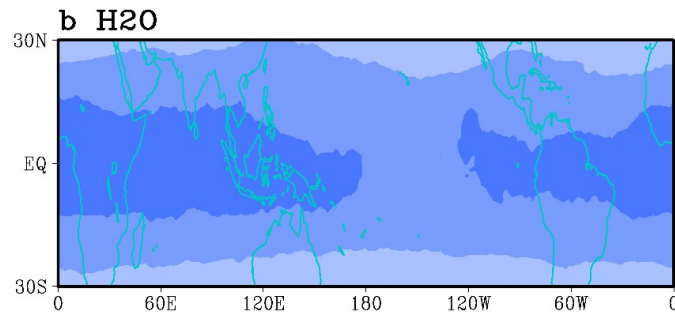
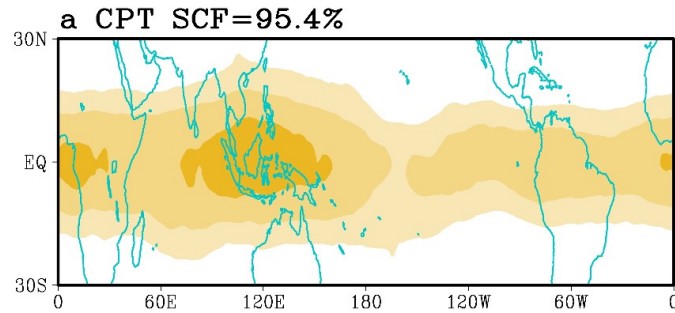
Tropical lower-stratospheric H₂O



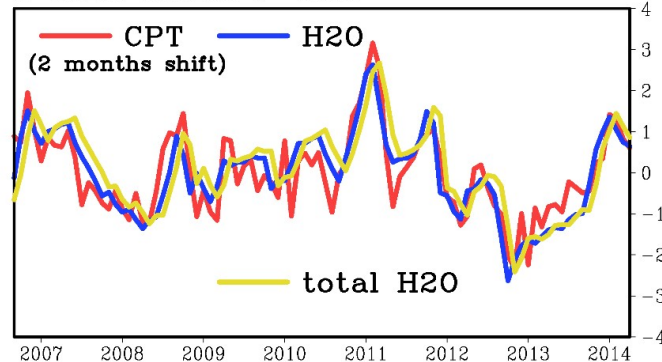
Observed
H₂O at
83hPa, T at
100hPa, and
QBO index
at 50 hPa for
1992– 2014.

Coupled patterns between tropical 83hPa water vapor and cold point tropopause (CPT) temperature for 2006-2014 from a maximum covariance analysis (MCA)

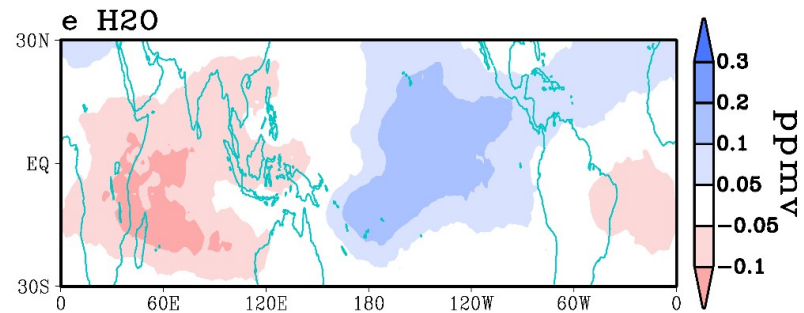
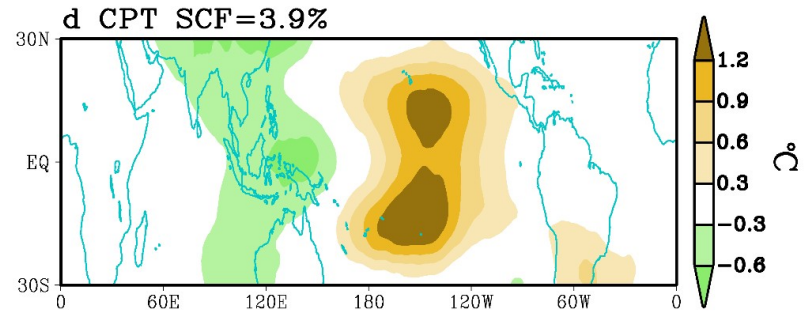
MCA1



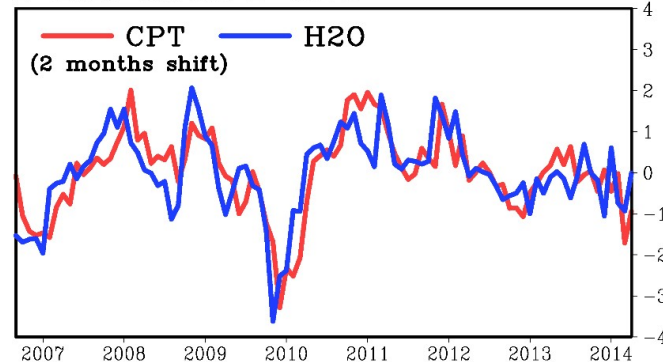
c time series $r=0.85$



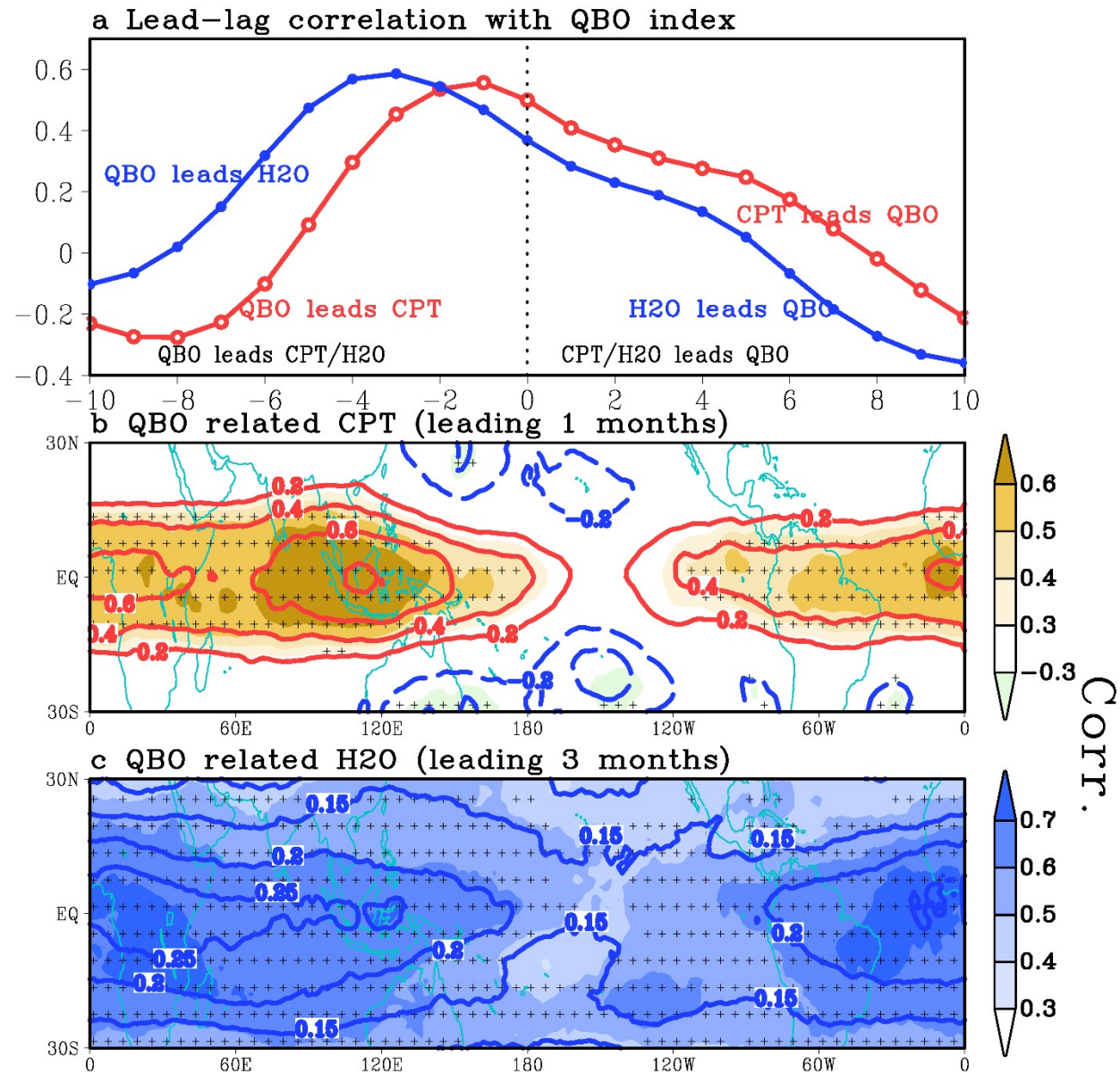
MCA2



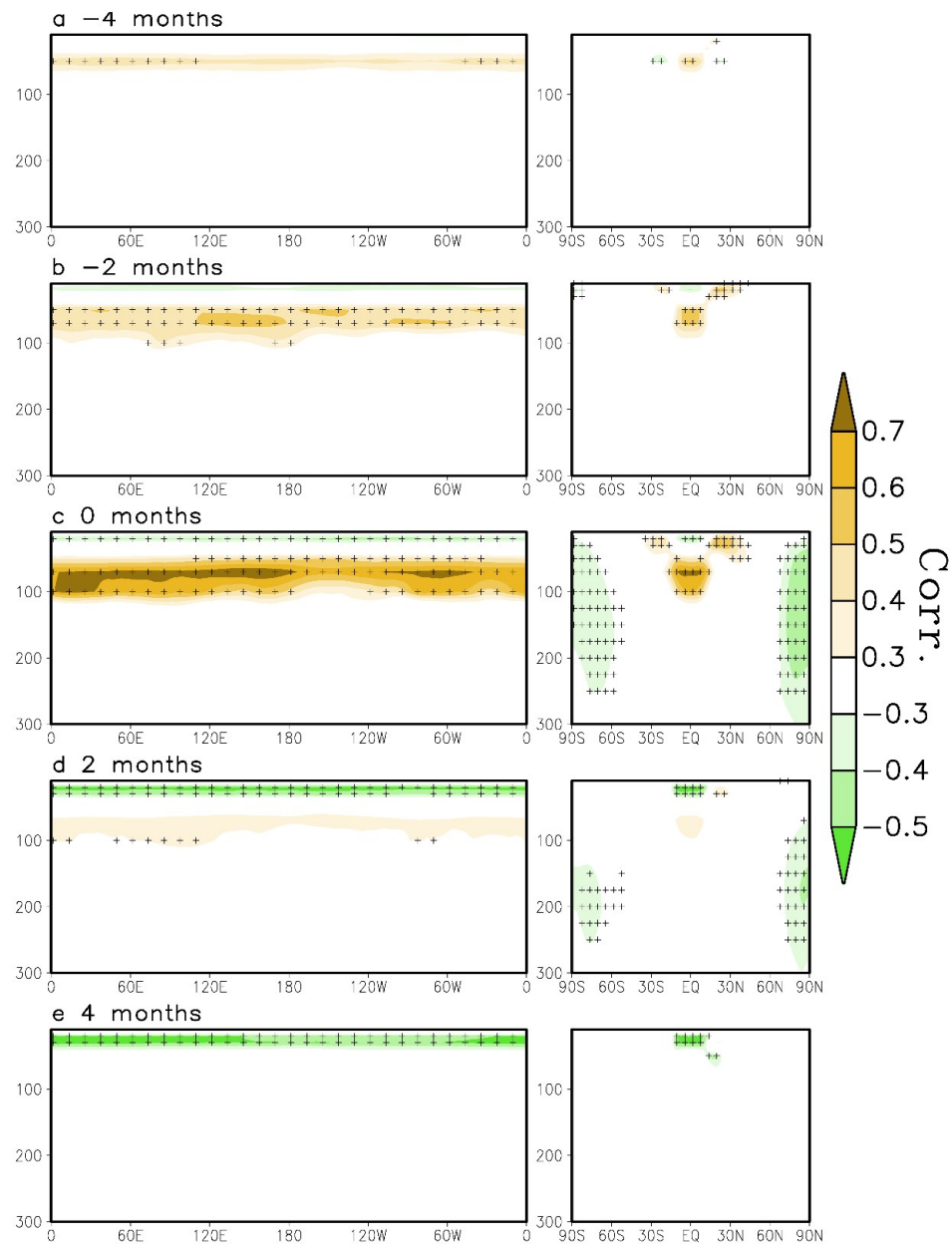
f time series $r=0.72$



MCA1 is primarily controlled by the QBO

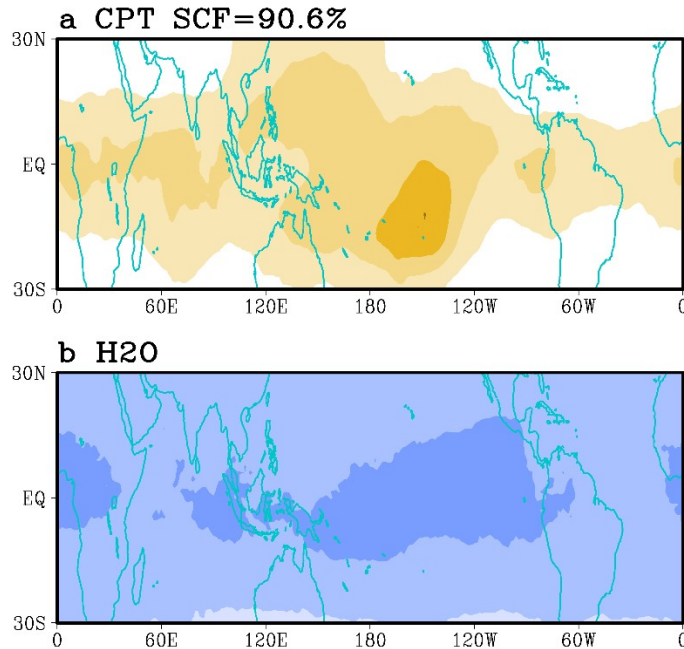


MCA1 is primarily controlled by the QBO

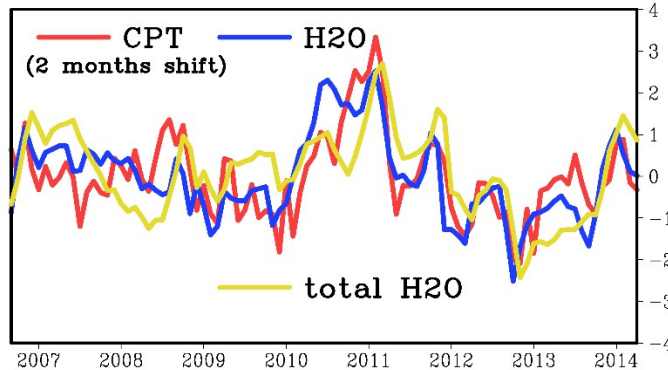


Coupled patterns between tropical 83hPa water vapor and CPT temperature for 2006-2014 after removing the QBO's impact

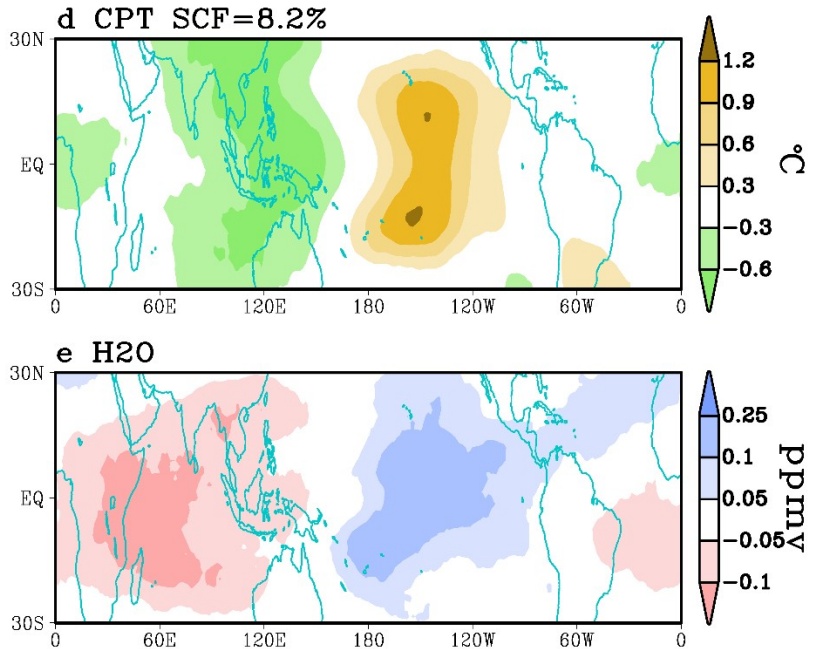
MCA1



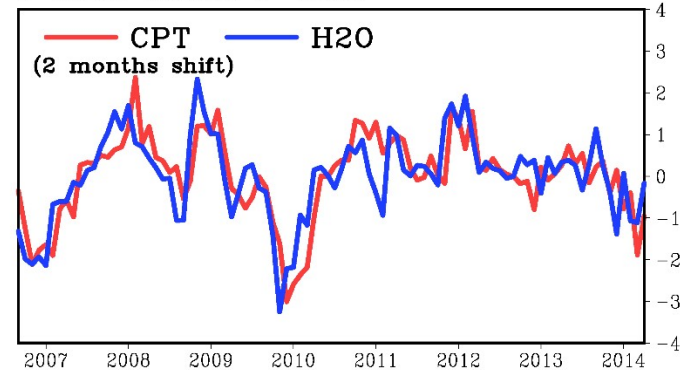
c time series $r=0.73$



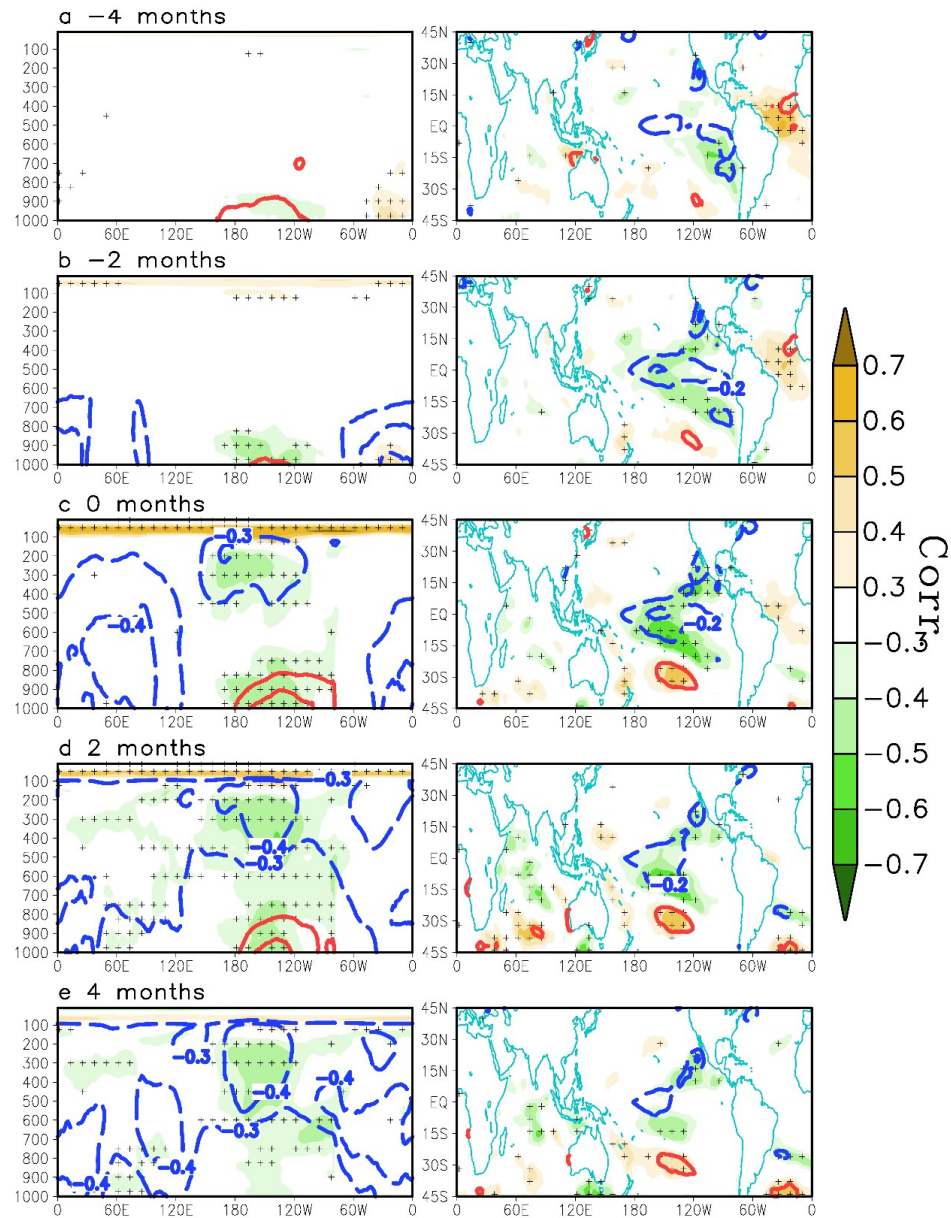
MCA2



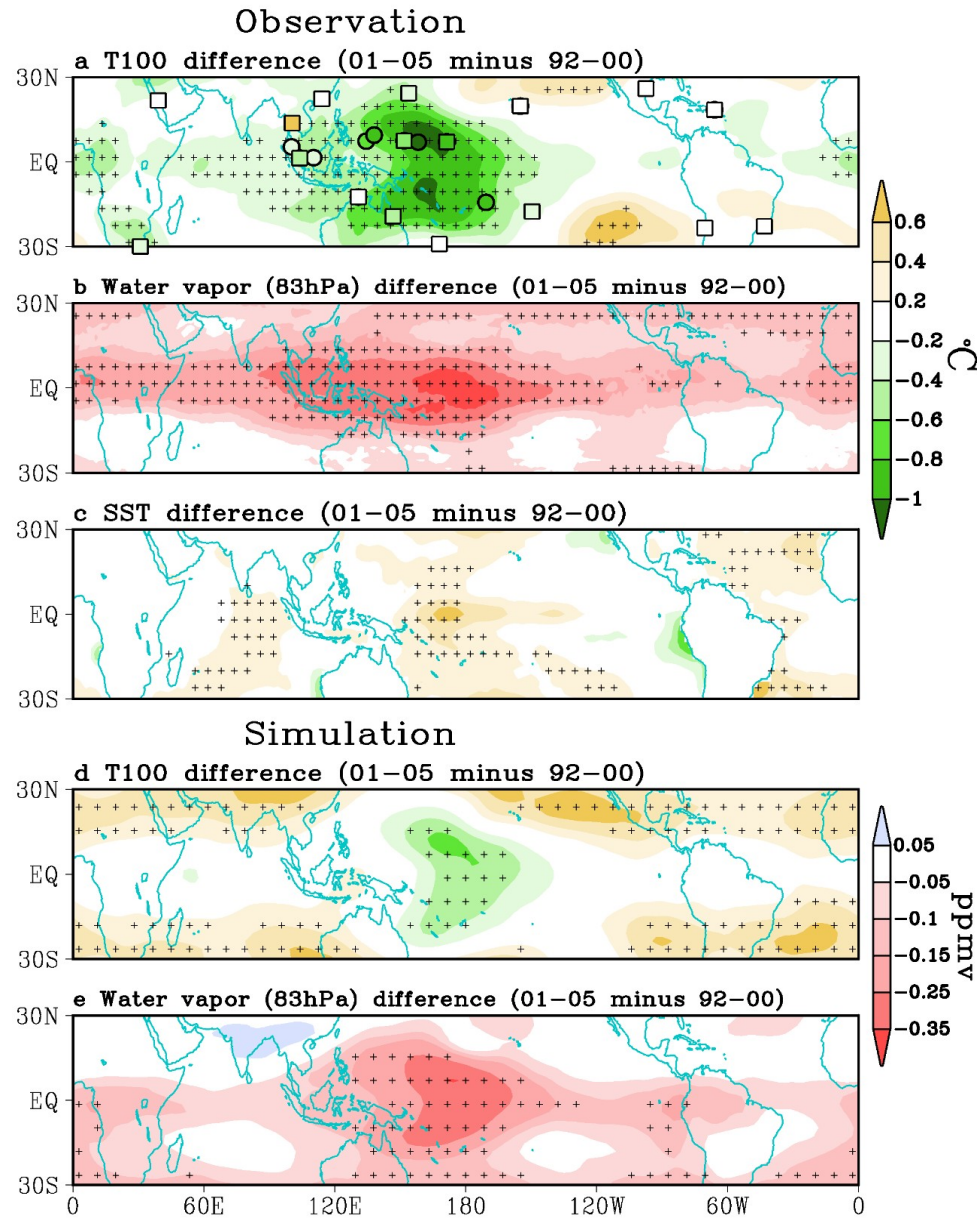
f time series $r=0.75$



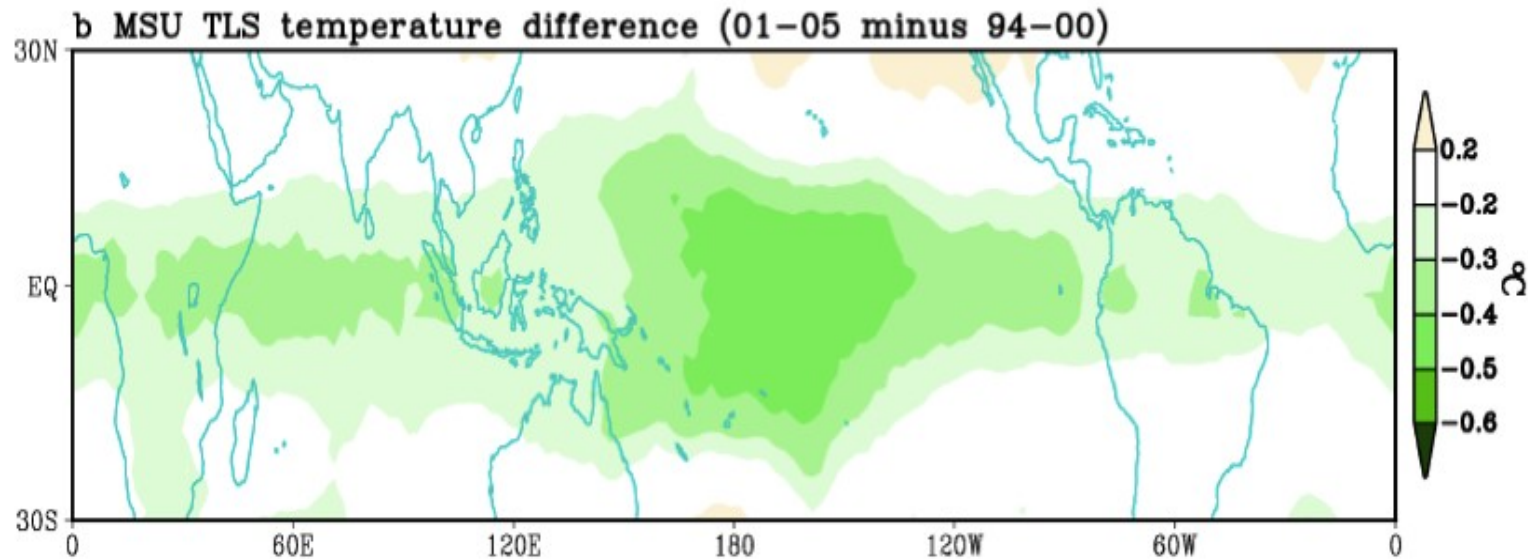
Evolution of tropospheric geopotential height, temperature and SST anomalies associated with CPT temperature MCA1 removing the QBO's impact



Observed and simulated 100hPa temperature and 83hPa water vapor variability associated with the 2000 “drying” event



Observed changes in lower stratospheric temperature associated with the 2000 “drying” event from MSU/AMSU (i.e., 2001-2005 minus 1994-2000).



Conclusions

- The water vapor “drying” event of 2000 was at least partly caused by a concurrent SST warming in the tropical central Pacific.
- The QBO affects TLS water vapor (top down) primarily on inter-annual time scales.
- Tropical central Pacific SST is the primary tropical driver (bottom up) of TLS water vapor variability, while a “classical” ENSO event has small effect on tropical mean TLS water vapor.
- The same analysis with data from 2005 to 2018 yields very similar results